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In the last years an increasingly used numerical tool to simulate fracture of materials and interfaces has been the cohesive zone (CZ) model, based on the definition of non-linear softening relationships between tractions and opening displacements at interfaces. Herein we focus specifically on debonding at bimaterial interfaces, or more in general on problems where the path of the debonding crack is known *a priori*. The numerical application of CZ models for debonding problems within finite element frameworks suffers from an intrinsic discretization sensitivity. Unless a sufficiently fine mesh discretizes the process zone of a cohesive crack, a sudden release of energy in large cohesive zone elements causes a sequence of snap-through or snap-back points in the global load-deflection response thus compromising the numerical efficiency [1]. In contrast to refinement of the entire domain, local refinement of the process zone is a computationally more efficient alternative. To this end, different surface enrichment strategies have been developed in the literature using different types of enrichment functions for CZ interface elements [1,2], as well as for contact elements [3]. These techniques, however, only affect the interacting surfaces and leave the bulk behaviour of the solid unaltered. Moreover, they typically do not increase the degree of continuity of the parameterization at the inter-element boundaries which is also responsible for unphysical stress oscillations at the interface.

The isogeometric analysis (IGA) framework [4] has already demonstrated to guarantee substantial advantages in the computational treatment of unilateral contact [5,6]. Differently from non-uniform rational B-splines (NURBS) built on rectangular grids in the parameter space, T-splines allow local refinement due to the introduction of T-junctions and extraordinary points. The T-Spline-based isogeometric approach is particularly suitable for CZ models, due to the high resolution required by these models in the process zone. Furthermore, in the isogeometric setting the discretized crack surfaces feature higher order inter-element continuity with respect to classical finite elements. In this contribution, debonding problems at known interfaces are treated with CZ modeling within the T-spline-based isogeometric framework. The interface is discretized with zero-thickness contact elements which account for both contact and debonding within a unified framework, using a Gauss-point-to-surface formulation. Depending on the contact status, an automatic switching procedure is used to choose between cohesive and contact models. The continuum is discretized with cubic T-splines, as well as with arbitrary order NURBS (Non Uniform Rational B-Splines) and Lagrange polynomial elements for comparison purposes. The cohesive law implemented here is bilinear, whose simple shape is able to capture the main characteristic parameters of interfaces, i.e. the cohesive strenghts, $P_{n,max}$ and the fracture energies, as well as the linear-elastic properties (slopes of the curve in the ascending branch).

The T-spline-based discretization is developed from the finite element point of view, using the Bézier extraction. The idea is to extract the linear operator which maps the Bernstein polynomial basis on Bézier elements to the global T-spline basis. In this way the isogeometric discretizations are automatically generated for any analysis-suitable CAD geometry and easily incorporated into existing finite element frameworks. Importantly, the use of a discretization based on Bézier extraction does not require a deep understanding of T-spline technology thus simplifying the integration of design and analysis. A commercial T-spline plugin has been introduced recently for Rhino3d by Autodesk [7] which is capable of defining and exporting analysis-suitable T-spline models (based on Bézier extraction) for use in IGA. This plugin is used to build the T-spline analysis models adopted in this study from a finite element point of view.

Results for a mode-I double cantilever beam (DCB) and a peel test between a rigid substrate and a thin elastic adherend with varying resolutions of the process zone and varying number of Gauss points are presented and compared in terms of local and global behaviour. The superior accuracy of T-splines interpolations with respect to NURBS and Lagrange ones for a given number of degrees of freedom and Gauss points is verified and discussed (compare i.e. the global load-displacement responses for two different meshes and three discretizations in Figure 1).

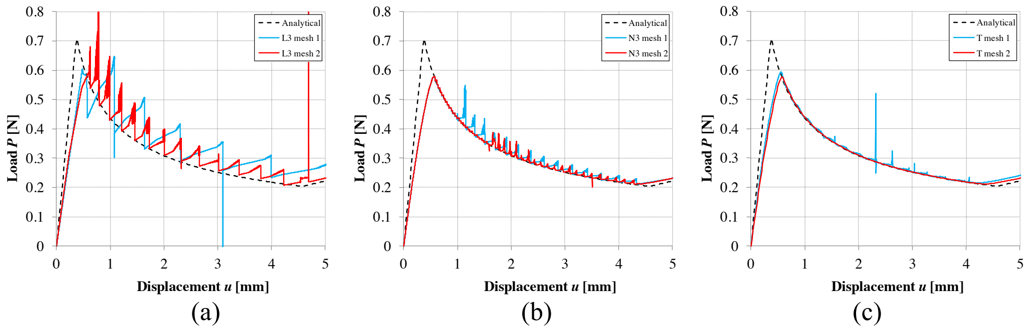

Figure 1: Load-displacement behaviour of a typical DCB for Lagrange (a), NURBS (b) and T-Splines (c) discretizations.

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